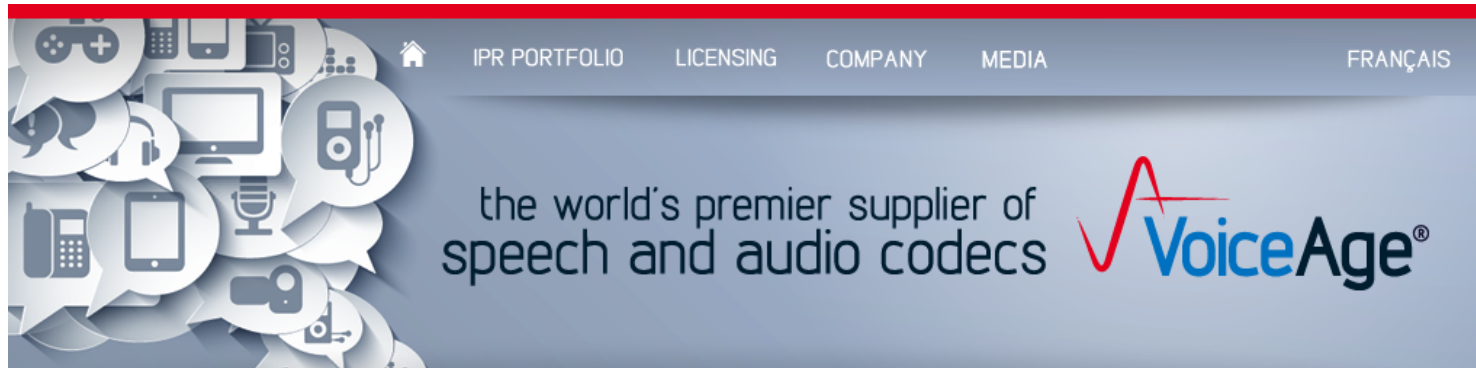


EXHIBIT C



EVS

The new codec for Enhanced Voice Services (EVS), successor of the current mobile HD voice codec AMR-WB, was standardized by the 3rd Generation Partnership Project (3GPP) in September 2014. The EVS codec addresses 3GPP's needs for cutting-edge technology enabling operation of 3GPP mobile communication systems in the most competitive means in terms of communication quality and efficiency.

The codec was developed by the collaboration between several leading companies in the industry including manufacturers (chipset, handset, infrastructure), operators, and technology providers. The standardization followed the rigorous 3GPP process which included setting aggressive requirements and designed constraints, with qualification, selection, and characterization phases comprising extensive subjective testing performed by world-known independent test labs.

Envisioned use cases for enhanced voice service include improved classical telco-grade telephony, and high-quality multi-party conferencing or audio-visual communication, offering a 'being-there' quality of experience. Even streaming voice and audio as well as offline voice and audio delivery are possible application scenarios.

EVS Codec Features

- Higher efficiency and transparent quality for narrowband (NB) and wideband (WB) services, for a large bit rate range, starting from 7.2 kbps.
 - Up to transparent wideband speech (at 24.4 kbps)
 - Up to transparent wideband mixed content and music (at 24.4 kbps)
 - Much improved compression efficiency at all rates:
 - Improved quality over AMR-NB and AMR-WB at similar rates
 - Unprecedented SWB quality at mobile rates (starting at 9.6 kbps)
- Provides a significant step in quality over traditional NB and WB telephony with super-WB (SWB) and full-band (FB) operation starting from 9.6 and 16.4 kbps, respectively.
- Unprecedented quality through SWB audio (14 or 16 kHz bandwidth) at mobile bitrates
 - From 9.6 kbps upwards
 - Highest quality speech, mixed content and music
 - Outperforms wideband in any operation point
- Ability to switch the bit rate at every 20-ms frame allows the codec to easily adapt to changes in channel capacity.
- Integrated AMR-WB interoperable mode over all nine bit rates from 6.6 to 23.85 kbps
 - Improved quality while 100% compatible to AMR-WB
 - Enables seamless integration of EVS into existing AMR-WB services
- Other features include:
 - Variable Bit Rate (VBR) mode for NB and WB operation at around 5.9 kbps average rate.
 - A mode interoperable with AMR-WB at all bit rates with improved quality over AMR-WB, especially for packet loss concealment
 - Discontinuous transmission (DTX) with algorithms for voice/sound activity detection (VAD) and comfort noise generation (CNG).
 - Highly robust error concealment mechanism for mitigating the quality impact of lost packets - fit for Voice over WLAN.
 - A system for jitter buffer management (JBM).
 - Ongoing work in 3GPP to introduce EVS in W-CDMA.
 - Transparent interoperability between LTE and W-CDMA using SRVCC

Technology

Standardized	3GPP 2014
Sampling rates	8, 16, 32 and 48 kHz

Licensing

[Overview](#)
[AMR-WB/G.722.2](#)
[AMR-NB \(AMR\)](#)

[EFR-GSM](#)
[EFR-TDMA](#)
[EFR-PDC](#)

[AMR-WB + EVRC Family](#)

[EVRC](#)
[EVRC-B](#)
[EVRC-C](#)
[EVRC-D](#)
[EVRC-E](#)

[EVS](#)
[MPEG-4 CELP](#)
[MPEG-H](#)
[SMV](#)
[VMR-WB](#)
[USAC](#)
[xHE-AAC](#)
[G.729.1](#)
[G.711.1](#)
[Audio Samples](#)

Modes & Encoded Bandwidth	NB (20-4000 Hz) WB (20-8000 Hz) SWB (20-16000 Hz) FB (20-20000 Hz)
Coding type	<ul style="list-style-type: none"> • ACELP/MDCT (content-driven switching between speech and audio compression) • Improved ACELP extended with specialized modes for different speech content • MDCT-based coding in different variants for audio coding <ul style="list-style-type: none"> ◦ Efficient MDCT coding at low delay/low bitrates ◦ seamless and reliable switching between the speech and the audio cores • Bandwidth extensions optimized for diverse content
Bit rate (kbps)	NB: 7.2, 8, 9.6, 13.2, 16.4, 24.4 WB: 7.2, 8, 9.6, 13.2, 16.4, 24.4, 32, 48, 64, 96, 128 SWB: 9.6, 13.2, 16.4, 24.4, 32, 48, 64, 96, 128 FB: 16.4, 24.4, 32, 48, 64, 96, 128 NB & WB VBR: ~5.9 kbps AMR WB Interoperable Mode: 6.6, 8.85, 12.65, 14.25, 15.85, 18.25, 19.85, 23.05, 23.85
Delay: Frame size Lookahead	20 ms 12 ms (extra encoder and decoder delay)
Quality	NB: Improved quality and packet loss robustness over AMR-NB WB: Improved quality and packet loss robustness over AMR-WB SWB: Unprecedented SWB quality at mobile bit rates (starting at 9.6 kbps) Mixed content and music: Significantly improved quality over AMR-WB
Jitter Buffer Management	Included
VAD/DTX/CNG	Included

Technology

Technical Specification

- [3GPP TS 26.441](#): General overview
- [3GPP TS 26.442](#): ANSI C code (fixed-point)
- [3GPP TS 26.443](#): ANSI C code (floating-point)
- [3GPP TS 26.444](#): Test sequences
- [3GPP TS 26.445](#): Detailed algorithmic description
- [3GPP TS 26.446](#): AMR-WB backward compatible functions
- [3GPP TS 26.447](#): Error concealment of lost packets
- [3GPP TS 26.448](#): Jitter buffer management
- [3GPP TS 26.449](#): Comfort Noise Generation (CNG) aspects
- [3GPP TS 26.450](#): Discontinuous Transmission (DTX)
- [3GPP TS 26.451](#): Voice Activity Detection (VAD)

Technical Report

[3GPP TR 26.952](#): EVS Codec Performance characterization

The TR provides information on the EVS codec Selection, Verification and Characterization Phases

Service-Related Specifications

- **EVS RTP Payload Format**: Specified in Annex A of [3GPP TS 26.445](#).
- **Media Type Parameters descriptions and handlings**: specified in this Annex A of [3GPP TS 26.445](#) and in [3GPP TS 26.114](#) (which also specifies other guidelines and operations necessary for the handling of the EVS codec such as QoS handling, codec control, and interworking with other networks)

For licensing IPR, please contact david@voiceageevs.com.

